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IDENTIFYING FACTORS AFFECTING THE MATHEMATICS ACHIEVEMENT THROUGH REVIEW ANALYSIS

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ABSTRACT

The quality of teaching and learning mathematics has been one of the major challenges and concerns of educators. Knowing the factors affecting math achievement is particularly important for making the best design decisions. This article was constructed to identify the factors affecting the math achievement of students through collecting the reviews. Results revealed that instructional strategies and methods, teacher competency in math education, and motivation or concentration were the three most influential factors that should be considered in the design decisions.

INTRODUCTION

As is the case in the past, most people today still believe that mathematics is all about computation. However, computation, for mathematicians, is merely a tool for comprehending structures, relationships and patterns of mathematical concepts, and therefore producing solutions for complex real life problems. This perspective of mathematicians has gained more attention and importance with rapid advancements in information and communication technologies. It has become necessity for people of all ages to reach, analyze, and apply the mathematical knowledge effectively and efficiently to be successful citizens in our information age. In particular, students need to be well-equipped with higher-order mathematical knowledge. The quality of teaching and learning in mathematics is a major challenge and for educators. General concern about mathematics achievement has been evident for the last 20 years. The current debate among scholars is what students should learn to be successful in mathematics. The discussion emphasizes new instructional design techniques to produce individuals who can understand and apply fundamental mathematic concepts.

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A central and persisting issue is how to provide instructional environments, conditions, methods, and solutions that achieve learning goals for students with different skill and ability levels. Innovative instructional approaches and techniques should be developed to ensure that students become successful learners. It is important for educators to adopt instructional design techniques to attain higher achievement rates in mathematics. (Rasmussen and Marrongelle, 2006). Considering students' needs and comprehension of higher-order mathematical knowledge, instructional design provides a systematic process and a framework for analytically planning, developing, and adapting mathematics instruction (Saritas, 2004). "[Instructional design] is an effective way to alleviate many pressing problems in education. Instructional design is a linking science – a body of knowledge that prescribes instructional actions to optimize desired instructional outcomes, such as achievement and effect" (Reigeluth, 1983, p.5). In an effort to understand the factors associated with mathematics achievement, researchers have focused on many factors. (Beaton and Dwyer, 2002; Kellaghan and Madaus, 2002; Kifer, 2002). The impact of various demographic, social, economical and educational factors on students' math achievement continues to be of great interest to the educators and researchers. For instance, Israel *et al.,* (2001) concluded that parents' socioeconomic status is correlated with a child's educational achievement. Another study by Jensen and Seltzer (2000) showed that factors such as individual study, parents' role, and social environment had a significant influence on "further education" decisions and achievements of young students'. In another study, Meece, Wigfield and Eccles (1990) investigated cognitive motivational variables that influence high school students' decisions to enroll in advanced math courses. Their findings revealed that math ability perceptions affect students' valuing of math and their expectations for achievement. A growing body of research provides additional factors which could have an impact on students' achievement such as *gender, family structure, parents' educational level, socio-economic status, parent and student attitudes toward school*, and *parent involvement* (Campbell *et al.,* 2000; Epstein, 1991; Fennema and Sherman, 1976, 1986; Fluty, 1997). Three factors or predictors in math achievement, are divided into sub factors: Demographic Factors (gender, socio-economic status, parent's educational level), Instructional Factors (teacher competency, instructional strategies and techniques, curriculum, school context and facilities), and Individual Factors (self-directed learning, arithmetic ability, motivation). These are examined in the literature review below. A growing body of research findings indicates that demographic, individual and instructional factors have an impact on the mathematical achievement of students. Identifying factors that affect mathematics achievement is particularly important to effectively educate new generations in, what is for many, a difficult subject. It also provides instructional designers better inputs for their design decisions.

Demographic Factors

Various demographic factors are known to be related to mathematics achievement. Gender, socio-economic status, and parents' educational level are factors that have been analyzed in this article as predictors of mathematics achievement.

Gender

Many variables have long been studied as predictors of mathematics achievement. However, gender issues on math achievement are studied most frequently by researchers. For instance, a study through a meta-analysis reveals that males tend to do better on mathematics tests that involve problem-solving (Hyde, Fennema, and Lamon 1990). Females tend to do better in computation, and there is no significant gender difference in understanding math concepts. Another study shows that females tend to earn better grades than males in mathematics (Kimball, 1989). Some recent studies have revealed that gender differences in mathematics education seem to be narrowing in many countries. However, studies indicate that as students reach higher grades, gender differences favor increase in math achievement by males (Campbell, 1995; Gray, 1996; Mullis, Martin, Fierros, Goldberg, and Stemler, 2000). For instance, the results from the Third International Mathematics and Science Study showed that mathematics achievement scores of each gender group were close to each other at the primary and middle school years (Beaton *et al.,*, 1996; Mullis *et al.,*, 1997). However, in the final year of secondary school, evidence was found for gender differences in mathematics achievement. Another study, which was conducted to analyze factors that affect math achievement of 11th-graders in math classes with an identified gender gap, also showed that males scored higher than females on 11th grade math achievement test, but this difference decreased from 10th grade (Campbell and Beaudry, 1998). In addition, gender differences in attitudes and perceptions of the usefulness of mathematics for middle school students were found statistically important (Lockheed, Thorpe, Brooks-Gunn, Casserly, and McAloon 1985; Oakes 1990). For example, female students show less interest in mathematics and have negative attitude toward mathematics. It is also reported that girls tend to learn mathematical concepts by means of rules or cooperative activities, while boys have a tendency to be in a competition to master mathematical concepts (Fennema and Peterson, 1985; Hopkins, McGillicuddy-De Lisi, and De Lisi, 1997).

Socio-Economic Status

Socio-economic status is determined to be a predictor of mathematics achievement. Studies repeatedly discovered that the parents' annual level of income is correlated with students' math achievement scores (Eamon, 2005; Jeynes, 2002; Hochschild, 2003; McNeal, 2001). Socio-economic status was found significant in primary math and science achievement scores (Ma and Klinger, 2000). Another study found poor academic achievement of Canadian students to be attributable to their low socio-economic status (Hull, 1990). Socio-economic status was examined and found to be one of the four most important predictors of discrepancy in academic achievement of Canadian students (aged 15) in reading, mathematics, and science by the Program for International Student Assessment (Human Resources Development Canada, Statistics Canada, and Council of Ministers of Education Canada, 2001). A number of studies showed that parents with higher socio-economic status are more involved in their children's education than parents of lower socio-economic status. This greater involvement results in development of positive attitudes of children toward school, classes, and enhancement of academic achievement (Epstein, 1987; Lareau, 1987; Stevenson and Baker, 1987). It is believed that low socio-economic status negatively influences academic achievement, in part, because it prevents students from accessing various educational materials and resources, and creates a distressing atmosphere at home (possible disruptions in parenting or an increased likelihood family conflicts) (Majoribank, 1996; Jeynes, 2002). For these reasons, socio-economic status of a student is a common factor that determines academic achievement.

Parents' Educational Level

Parents' educational level has been shown to be a factor in academic achievement. Parents serve as a role model and a guide in encouraging their children to pursue high educational goals and desires by establishing the educational resources on hand in the home and holding particular attitudes and values towards their children's learning. In this case, the educational attainment of parents serve as an indicator of attitudes and values which parents use to create a home environment that can affect children's learning and achievement. A number of studies indicated that student achievement is correlated highly with the educational attainment of parents (Coleman, 1966). For instance, students whose parents had less than high school education obtained lower grades in mathematics than those whose parents had higher levels of education (Campbell, Hombo, and Mazzeo, 2000). Research has shown that parents' educational level not only impact student attitudes toward learning but also impact their math achievement scores.

Instructional Factors

Curriculum

Many concerns have been emphasized in the literature about the existing math curricula that emphasize

. . . not so much a form of thinking as a substitute for thinking. The process of calculation or computation only involves the deployment of a set routine with no room for ingenuity or flair, no place for guess work or surprise, no chance for discovery, no need for the human being, in fact (Scheffler, 1975, p.184).

The concerns here are not that students should never learn to compute, but that students must learn how to critically analyze mathematical problems and produce effective solutions. This requires them to learn, how to make sense of complex math concepts and how to think mathematically (Cobb *et al.,*, 1992). Many mathematics curricula overemphasize memorization of facts and underemphasize understanding and application of these facts to discover, make connections, and test math concepts. Memorization must be raised to conceptualization, application and problem-solving for students to successfully apply what they learn. An impressive body of research suggests that curriculum that considers students to be incapable of metacognitive actions (e.g., complex reasoning) should be replaced with the one that sees students who are capable of higher-order thinking and reasoning when supported with necessary and relevant knowledge and activities (Bransford *et al.,*, 1994; Schauble *et al.,*, 1995; Warren andRosebery, 1996). Research has also revealed evidence that curricula in which students' knowledge and skills grow is significantly connected to their learning, and therefore their achievement (Brown and Campione, 1994; Lehrer and Chazan, 1998).

Instructional Strategies and Methods

Being successful in math involves the ability to understanding one's current state of knowledge, build on it, improve it, and make changes or decisions in the face of conflicts. To do this requires problem solving, abstracting, inventing, and proving (Romberg, 1983). These are fundamental cognitive operations that students need to develop and use it in math classes. Therefore, instructional strategies and methods that provide students with learning situations where they can develop and apply higher-order operations are critical for mathematics achievement. In the literature, it is pointed out that for students to accomplish learning, teachers should provide meaningful and authentic learning activities to enable students to construct their understanding and knowledge of this subject domain (Wilson, 1996). In addition, it is emphasized that instructional strategies where students actively participate in their own learning is critical for success (Bloom, B. 1976). Instructional strategies shape the progress of students' learning and accomplishment.

Teacher Competency in Math Education

Many studies report that what teachers know and believe about mathematics is directly connected to their instructional choices and procedures (Brophy, 1990; Brown, 1985; National Council of Teachers of Mathematics, 1989; Thompson, 1992; Wilson, 1990a, b). Geliert (1999) also reported that "in mathematics education research, it seems to be undisputed that the teacher's philosophy of mathematics has a significant influence on the structure of mathematics classes" (p. 24). Teachers need to have skills and knowledge to apply their philosophy of teaching and instructional decisions. In the 21st century, one shifting paradigm in education is about teachers' roles and competencies. Findings from research on teacher competency point out that

If teachers are to prepare an ever more diverse group of students for much more challenging work--for framing problems; finding, integrating and synthesizing information; creating new solutions; learning on their own; and working cooperatively--they will need substantially more knowledge and radically different skills than most now have and most schools of education now develop (Darling-Hammond, 1997, p. 154).

Teachers not only need knowledge of a particular subject matter but also need to have pedagogical knowledge and knowledge of their students (Bransford *et al.,*, 2000). Teacher competency in these areas is closely linked to student thinking, understanding and learning in math education. There is no doubt that student achievement in math education requires teachers to have a firm understanding of the subject domain and the epistemology that guides math education (Ball, 1993; Grossman *et al.,*, 1989; Rosebery *et al.,*, 1992) as well as an equally meticulous understanding of different kinds of instructional activities that promote student achievement. Competent math teachers provide a roadmap to guide students to an organized understanding of mathematical concepts, to reflective learning, to critical thinking, and ultimately to mathematical achievement.

School Context and Facilities

School context and its facilities could be an important factor in student achievement. In fact, identifying factors related to the school environment has become a research focus among educational practitioners. For instance, research suggests that student achievement is associated with a safe and orderly school climate (Reyonds *et al.,*, 1996). Researchers also found a negative impact on student achievement where deficiencies of school features or components such as temperature, lighting, and age exist. In a study by Harner (1974), temperatures above 23° C (74° F) adversely affected mathematics skills. In terms of the condition of school building, Cash (1993) found student achievement scores in standard buildings to be lower than the scores of students in above standard buildings. In addition, Rivera-Batiz and Marti (1995) conducted multiple regression statistical analysis to examine the relationship between overcrowded school buildings and student achievement. The findings indicated that a high population of students had a negative effect on student achievement.

Individual Factors

Self-Directed Learning

Self-directed learning could be a factor in students' math achievement. Mathematics learning requires a deep understanding of mathematical concepts, the ability to make connections between them, and produce effective solutions to ill-structured domains. There is no perfect, well-structured, planned or prescribed system that lets students think and act mathematically. This can be done if, and only if, students play their assigned roles in their learning progress. Self-directed learning has an important place in successful math learning. Self-directed students can take the initiative in their learning by diagnosing their needs, formulating goals, identifying resources for learning, and evaluating or monitoring learning outcomes (Knowles 1975). The teacher's role is to engage students by helping to organize and assist them as they take the initiative in their own self-directed explorations, instead of directing their learning autocratically (Strommen and Lincoln, 1992).

Arithmetic Ability

Arithmetic ability could also be another predictor of math achievement. Arithmetic ability includes the skills such as manipulating mathematical knowledge and concepts in ways that transform their meaning and implications. It allows students to interpret, analyze, synthesize, generalize, or hypothesize the facts and ideas of mathematics. Students with high arithmetic ability or mathematical reasoning can engage in tasks such as solving complex problems, discovering new meanings and understanding, and arriving at logical conclusions. Arithmetic ability was determined by various studies as a critical factor on students' math achievement. For instance, in a study by Kaeley (1993), arithmetic ability gave the highest correlation coefficient with mathematics achievement. Similarly, student achievement scores were found to be most strongly predicted by level of ability (Schiefele and Csikszentmihalyi, 1995). Some other researchers have also investigated the relationship of gender issues and arithmetic ability on math achievement. For instance, Mills (1997) conducted a study to investigate longitudinal data gathered over 10 years with an aim at asking whether personality traits were related to gender differences in long-term achievement in mathematics and the sciences. The study revealed that math ability was the most significant predictor of long-term achievement in math for young women. However, the level of math ability did not seem to be a factor of long-term math achievement for young men.

Motivation or Concentration

Mathematics education requires highly motivated students because it requires reasoning, making interpretations, and solving problems, mathematical issues, and concepts. The challenges of mathematics learning for today's education is that it requires disciplined study, concentration and motivation. To meet these challenges, learners must be focused and motivated to progress. Broussard and Garrison (2004) examined the relationship between classroom motivation and academic achievement in elementary-school-aged children (122-first grade and 129-third grade participants). Consistent with previous studies, they found that for a higher level of mastery, motivation was related to higher math grades. The teacher's role in students' motivation to learn should not be underestimated. In helping students become motivated learners and producers of mathematical knowledge successfully, the teacher's main instructional task is to create a learning environment where students can engage in mathematical thinking activities and see mathematics as something requiring "exploration, conjecture, representation, generalization, verification, and reflection" (Carr, 1996, p.58).

Conclusion

This article reported that mathematics course is important and should be compatible to the factors identified for mathematics achievement. Educators need to adapt and create alternative innovative learning and teaching strategies for effective mathematics education. It is important to embody diagnostic and prescriptive tools to determine the best-fit design for each individual learner, and to make learning more meaningful based on known critical factors that affect mathematics achievement.

REFERENCES

Ball, D.L. 1993. With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *Elementary School Journal 9,* p. 373-397.

Beaton, A. E., and O'Dwyer, L., M. 2002. Separating school, classroom and student variances and their relationship to socioeconomic status.In D. F. Robitailleand A. E. Beaton (Eds.), Secondary analysisofthe TIMSS data (pp.2 11-231. Boston, MA: Kluwer Academic Publishers.

Beaton, A. E., Mullis, I. V., S., Martin, M. O., Gonzalez, E. J., Kelly, D. L., and Smith, T. A. 1996. *Mathematics achievement in the middle school years: IEA's Third International Mathematics and Science Study*. Chestnut Hill, MA: Boston College.

Bloom, B. 1976. *Human Characteristics and School Learning*. New York: McGraw Hill, Inc.

Bransford, J. D., Brown, A. L., and Cocking, R. R. 2000. *How People Learn: Brain, Mind, Experience, and School: Expanded Edition*. Washington, D.C.: National Academy Press.

Brophy, J.E. 1990. Teaching social studies for understanding and higher-order applications.*Elementary School Journal, 90* (351-417.

Broussard, S. C., and Garrison, M. E. B. 2004. The relationship between classroom motivation and academic achievement in elementary-school-aged children. *Family and Consumer Sciences Research Journal, 33*(2), 106-120.

Brown, A.L., and Campione, J.C. 1994. Guided discovery in a community of learners. Pp. 229-270 in*Classroom Lessons: Integrating Cognitive Theory and Classroom Practice*, K. McGilly, ed. Cambridge, MA: MIT Press.

Brown, C. A. 1985. A study of the socialization to teaching of a beginning secondary mathematics teacher.Unpublished doctoral dissertation.University of Georgia.

Campbell, J. R., Hombo, C. M., and Mazzeo, J. 2000. *NAEP 1999 trends in academic progress:Three decades of* *student performance.* Washington, DC: National Center for Education Statistics.

Campbell, J.R., andBeaudry, J.S. 1998. "Gender gap linked to differential socialization for high-achieving senior mathematics." *Journal of educational research* 91, 140-147.

Campbell, P. B. 1995. Redefiningthe"girlproblem"in mathematics. In W. G. Secada, E. Fennema, and L. B. Adjian (Eds.), Newdirectionsforequity in mathematics education (pp. 225-241. Cambridge: Cambridge University Press.

Carr, M. 1996. *Motivation in Mathematics*. New York: Hampton Press, Inc.

Cash, C. S. 1993. *Building condition and student achievement and behavior*.Unpublished doctoral dissertation.Virginia Polytechnic Institute and State University.

Cobb, P., Yackel, E., and Wood, T. 1992. A constructivist alternative to the representational view of mind in mathematics education. *Journal for Research in Mathematics Education 19*, 99-114.

Colakoglu, O., and Akdemir, O. 2008. *Motivational Measure of the Instruction Compared: Instruction Based on the ARCS Motivation Theory versus Traditional Instruction in Blended Courses.* Paper presented at the World Conference on Educational Multimedia, Hypermedia and Telecommunications 2008, Chesapeake, VA.

Coleman, J. S. 1966. *Equality of educational opportunity*. Washington, DC: U.S. Government Printing Office.

Darling-Hammond, L. 1997. School reform at the crossroads: Confronting the central issues of teaching. *Educational Policy 11*(2), 151-166.

Dursun, S. and Dede, Y. 2004. The Factors Affecting Students Success in Mathematics: Mathematics Teachers Perspectives. *Journal of Gazi Educational Faculty 24*(2), 217-230.

Epstein, J. L. 1991. Effects on student achievement of teachers' practices of parent involvement. In S.B. Silvern (Ed.), *Advances in readings/language research* (5th ed., pp. 261-276. Greenwich, CT: JAI Press.

Fennema, E., and Peterson, P. 1985. Autonomous learning behavior: A possible explanation of gender-related differences in mathematics. In L. C. Wilkinson and C. B. Marrett (Eds.), *Gender influences in classroom interaction* (pp. 17-35. New York: Academic Press.

Fluty, D. 1997. Single parenting in relation to adolescents' achievement scores. *Research Center for Families and Children, 6*, 4-8.

Gellert, U. 1999. Prospective elementary teachers' comprehension of mathematics instruction.*Educational Studies in Mathematics, 37*, 23-43.

Gray, M. 1996. Gender and mathematics: Mythology and misogyny. In G. Hanna (Ed.), Towards gender equity in mathematics education: An ICMI study (pp. 27-38. Boston, MA: Kluwer Academic Publishers.

Grossman, P.L., Wilson, S.M., and Shulman, L.S. 1989. Teachers of substance: Subject matter for teaching. Pp. 23-36 in *Knowledge Base for the Beginning Teacher*, M.C. Reynolds, ed. New York: Pergamon Press.

Harner, D. P. 1974. Effects of thermal environment on learning skills. *CEFP Journal (12),* 4-8.

Hopkins, K. B., McGillicuddy-De Lisi, A. V., and De Lisi, R. 1997. Student gender and teaching methods as sources of variability in children's computational arithmetic performance. *The Journal of Genetic Psychology, 158*, 333-345.

Hull, J. 1990. Socioeconomic status and native education. *Canadian Journal of Native Education, 17*, 1-14.

Human Resources Development Canada, Statistics Canada, and Council of Ministers of Education Canada 2001. *Measuring up: The performance of Canada's youth in reading, mathematics and science*. Ottawa: Authors.

Hyde, J. S., Fennema, E. H., and Lamon, S. J. 1990. Gender Differences in Mathematics Performance: A Meta-Analysis. *Psychological Bulletin 107*, 139-55.

Hyde, J. S., Fennema, E., Ryan, M., Frost, L. A., and Hopp, C. 1990. Gender comparisons of mathematics attitudes and affect: A meta-analysis. *Psychology of women quarterly 14(3)*, 299-324.

Israel, G.D., Beaulieu, L.J., and Hartless, G. 2001. The Influence of Family and Community Social Capital on Educational Achievement. *Rural Sociology, 66 (1)*, 43-68.

Jensen, B. and Seltzer, A. 2000. Neighborhood and Family Effects in Educational Progress. *The Australian Economic Review, 33 (1)*, 17-31

Jeynes, W. H. 2002. Examining the Effects of Parental Absence on the Academic Achievement of Adolescents: The Challenge of Controlling for Family Income. *Journal of Family and Economic Issues, 23* (2), 189-210.

Kaeley, G. S. 1983. Explaining mathematics achievement of mature internal and external students at the University of Papua New Guinea. *Educational Studies in Mathematics, 25*(3), 251-260.

Kellaghan, T., and Madaus, G. F. 2002. Teachers' sources and uses of assessment information.In D. F.Robitailleand A. E. Beaton (Eds.), *Secondary analysis of the TIMSS data*. Boston, MA: Kluwer Academic Publishers.

Kifer, E. W. 2002. Students' attitudes and perceptions. In D. F. Robitailleand A. E. Beaton (Eds.),*Secondary analysis of the TIMSS data*. Boston: Kluwer Academic Publishers.

Kimball, M. M. 1989. A New Perspective on Women's Math Achievement. *Psychological Bulletin 105*, 198-214.

Knowles, M. 1975. *Self-Directed Learning: A Guide for Learners and Teachers*. New York: Association Press.

Lareau, A. 1987. Social class differences in family-school relationships: The importance of Cultural capital. *Sociology of Education, 60*, 73-85.

Lehrer, R., and Chazan, D. 1998. *Designing learning environments for developing understanding of geometry and space*. Mahwah, NJ: Erlbaum.

Libienski, S. T. and Gutierrez, R. 2008. *Bridging the Gaps in perspectives on Equity in Mathematics Education*. Journal for Research in Mathematics Education*, 39 (4)*, 365-371.

Lockheed, M.E., Thorpe, M., Brooks- Gunn, J., Casserly, P., andMcAloon, A. 1985. *Sex and Ethnic Differences in Middle School Mathematics, Science and Computer Science: What Do We Know?* Princeton, NJ: Educational Testing Service

Marjoribanks, K. 1996. Family learning environment and students' outcomes : A review. *Journal of Comparative Family Studies, 27*, 373-394.

Meece, J.L., Wigfield, A., and Eccles, J.S. 1990. Predictors of math anxiety and its influence on young adolescent's course enrollment intentions and performance in mathematics. *Journal of Educational Psychology 82 (1)*, 60-70.

Mills, C. J. 1997. *Gender differences in math/science achievement: The role of personality variables.*Paper presented at the 20th Annual Conference of the Eastern Educational Association, Feb. 1997, Hilton Head, South Carolina.

Mullis, I. V. S., Martin, M. O., Beaton, A., E., Gonzalez, E., J., Kelly, D., L., and Smith, T. A. 1997. *Mathematics achievement in the primary school years: IEAs Third International and Mathematics and ScienceStudy*. ChestnutHill,MA: BostonCollege.

Mullis, I. V. S., Martin, M. O., Fierros, E. G., Goldberg, A. L., andStemler, S. E. 2000. *Gender differences in achievement: IEA's Third International Mathematics and Science Study.* Chestnut Hill, MA: Boston College.

National Council of Teachers of Mathematics 1989. *Curriculum and evaluation standards for school mathematics.* Reston, VA: National Council on Teachers of Mathematics.

Oakes, J. 1990. Opportunities, Achievement, and Choice: Women and Minority Students in Science and Mathematics. *Review of Research in Education 16*,153-222.

Rasmussen, C. and Marrongelle, K. 2006. Pedagogical Content Tools: Integrating Student Reasoning and Mathematics in Instruction. Journal for Research in Mathematics Education*, 37 (5)*, 388-420.

Reigeluth, C., M. 1983. *Instructional-Design Theories and Models: An Overview of Their Current Status*. Lawrence Erlbaum Associates: New Jersey

Reyonds, D., Bollen, R., Creemers, B., Hopkins, D., Stoll, L., andLagerweij, L. 1996. *Making good schools: Linking effectiveness and school improvement.* London: Routledge.

Rivera-Batiz, F. L. and Marti, L. 1995. *A school system at risk: A study of the consequences of overcrowding in New York City public schools.* New York: Institute for Urban and Minority Education, Teachers College, Columbia University.

Romberg, T.A. 1983. A common curriculum for mathematics. Pp. 121-159 in *Individual Differences and the Common Curriculum: Eighty-second Yearbook of the National Society for the Study of Education, Part I.* G.D. Fenstermacher and J.I. Goodlad, eds. Chicago: University of Chicago Press.

Rosebery, A.S., Warren, B., and Conant, F.R. 1992. Appropriating scientific discourse: Findings from language minority classrooms. *The Journal of the Learning Sciences* 2(1), 61-94.

Saritas, M. 2004. Instructional Design in Distance Education (IDDE): Understanding the Strategies, Applications, and Implications. In C. Crawford *et al.,* (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference 2004* (pp. 681-688. Chesapeake, VA: AACE.

Schauble, L., Glaser, R., Duschl, R., Schultz, S., and John, J. 1995. Students' understanding of the objectives and procedures of experimentation in the science classroom. *The Journal of the Learning Sciences, 4*(2), 131-166.

Scheffler, I. 1975. Basic mathematical skills: Some philosophical and practical remarks. In *National Institute of Education Conference on Basic Mathematical Skills and Learning, Vol. 1*. Euclid, OH: National Institute of Education.

Schiefele, U. andCsikszentmihalyi, M. 1995. Motivation and ability as factors in mathematics experience and achievement. *Journal of Research in Mathematics Education, 26*(2), 163-181.

Stevenson, D. L., and Baker, D. P. 1987. The family-school relation and the child's school Performance. *Child Development, 58*, 1348-1357.

Strommen, E., F., and Lincoln, B. 1992. *Constructivism, Technology, and The Future of Classroom Learning.* Children's Television Workshop.

Thompson, A. G. 1992. Teachers' beliefs and conceptions: A synthesis of the research. Pp. 127-146 in *Handbook of Research in Mathematics Teaching and Learning,* D.A. Grouws, ed. New York: Macmillan.

Warren, B., and Rosebery, A. 1996. This question is just too, too easy: Perspectives from the classroom on accountability in science. Pp. 97-125 in the *Contributions of Instructional Innovation to Understanding Learning*, L. Schauble and R. Glaser, eds. Mahwah, NJ: Erlbaum.

Wilson, M. 1990. Investigation of structured problem solving items. Pp. 137-203 in *Assessing Higher Order Thinking in Mathematics,* G. Kulm, ed. Washington, DC: American Association for the Advancement of Science.

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